GB04/04249

The Patent Office

INVESTOR IN PEOPLE

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

REC'D 22 OCT 2004
WIPO PCT

PRIORITY DOCUMENT

SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed R. Mahoney

Dated 15 October 2004

BEST AVAILABLE COPY

Patents Form 1/77

Patents Act 1977
(Rule 16)

1/77

09OCT03 E843240-1 D00355
P01/7700 0.00-0323611.4

The Patent Office

Cardiff Road
Newport
South Wales
NP10 8QQ

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

1.	Your reference	F071867PGB
2.	Patent application number *(The Patent Office will fill in this part)*	0323611.4 — - 9 OCT 2003
3.	Full name, address and postcode of the or of each applicant *(underline all surnames)*	TRELLEBORG AB (publ) P O Box 153 SD-231 22 Trelleborg Sweden
	Patents ADP number *(if you know it)*	8726549001
	If the applicant is a corporate body, give the country/state of its incorporation	Sweden
4.	Title of the invention	Vibration Mounting
5.	Name of your agent *(if you have one)* "Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	Marks & Clerk Alpha Tower Suffolk Street Queensway Birmingham B1 1TT
	Patents ADP number *(if you know it)*	18002

		Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*
6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number			

		Number of earlier application	Date of filing *(day / month / year)*
7.	If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application		

8.	Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:* *a) any applicant named in part 3 is not an inventor, or* *b) there is an inventor who is not named as an applicant, or* *c) any named applicant is a corporate body.* *See note (d))*	YES

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	11
Description	
Claim *(s)*	
Abstract	
Drawing *(s)*	3 + 3

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	2
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature   Date 8 OCT 2000

12. Name and daytime telephone number of person to contact in the United Kingdom   Sean J HACKETT   0121 643 5881

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

a) *If you need help to fill in this form or you have any questions, please contact the Patent Office on 08459 500505.*

b) *Write your answers in capital letters using black ink or you may type them.*

c) *If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.*

d) *If you have answered 'Yes' Patents Form 7/77 will need to be filed.*

e) *Once you have filled in the form you must remember to sign and date it.*

[illegible]

VIBRATION MOUNTING

The present invention relates to a vibration mounting. In particular, but not exclusively, the present invention relates to a vibration mounting for an engine.

Vibration mountings are known in which a resilient rubber material is sandwiched between a base member secured to a foundation (e.g. a floor such as the hull of a boat or a frame), and a support member. The support member is attached to a foot or mounting point on an engine or other piece of equipment that may be subjected to vibrations. The purpose of the vibration mounting is to isolate the vibration energy of the engine and so prevent damage to the engine or to equipment or personnel located nearby.

A problem with such vibration mountings arises when the vibration frequency is low, especially, for example, in two or three-cylinder marine engines. Such engines are used in smaller sea-going vessels and not only generate low frequency vibrations themselves, but are subjected to increased loadings on the mountings due to the pitching and rolling motion of the vessel. Marine engines, as with many types of engine, are now producing more power now than they ever have, giving rise to a need for a mounting that provides the required vibration isolation combined with a high thrust load capacity.

Furthermore, the engines are often mounted directly to the hull of the vessel and transmission of vibrations from the engine could result in weakening of the hull with potentially disastrous consequences. To isolate the low frequency vibrations, large displacements of the rubber material are required. Large displacements require larger volumes of rubber to ensure adequate absorption of vibration energy while maintaining reasonable service life. This means that vibration mountings of known design would have to be unacceptably large or unable to be used on existing or industry-standard mounting positions to be suitable for low frequency isolation.

A further problem is that excessively large displacements are undesirable because they may damage engine components or equipment connected to the engine

such as gear trains or fuel lines. This problem is particularly severe in two and three-cylinder marine engines, when operating at maximum capacity because very high loads are transmitted in the direction of the engine thrust (longitudinal direction). Thus a higher rate of resistance to large displacements (stiffness) is required in this direction, while maintaining isolation in the vertical and/or lateral directions. This is usually achieved by fitting thrust bearings to the power output shaft of the engine, adding considerably to the installation cost.

Although it is known to use hydraulic mountings to dampen low frequency vibrations, these mountings provide inadequate isolation of higher frequency vibrations. High frequency vibrations are transmitted through the hydraulic fluid, which behaves like a solid in such conditions.

It is an object of the present invention to provide a vibration mounting which alleviates these problems.

According to the present invention there is provided a vibration mounting comprising a base member mountable to a mounting location and a support member for supporting a load, the support member being spaced apart from the base member in a load-bearing direction by a vibration isolating element of a resilient material,

wherein the vibration isolating element comprises a first plurality of lobes extending between the base member and the support member in a first direction.

Preferably, the first direction is substantially orthogonal to the load-bearing direction.

In a preferred embodiment, the vibration isolating element further comprises a second plurality of lobes extending between the base member and the support member in a second direction, substantially opposite to the first direction.

It is an advantage that deflection of the load-bearing member towards the base member causes deformation of the lobes by a combination of shear and compression. Deformation by shear provides a lower stiffness than pure compression and allows

large deflections without the need for an excessive quantity of material. It is a further advantage that the lobes provide an increased free surface area for allowing lateral expansion of the rubber material when compressed, thereby further reducing the compression stiffness of the rubber element.

Preferably the lobes are arranged to extend outwardly from a central portion of the vibration isolating element secured to a raised portion of the base member, and at an angle to the base member, an outward end of each lobe engaging a corresponding portion of the support member. The corresponding portion of the support member may be an end portion extending towards the base member that bears against an outer end surface of the lobe. It is an advantage that the end portions provide support for the load in the longitudinal direction, provide accurate control of stiffness, ensure that the rubber lobes are compressed in use, and substantially reduce the friction caused by relative movement between the lobes and the support member.

In a preferred embodiment, the support member comprises one or more buffer members extending towards the base member between adjacent lobes of the vibration isolating element such that the buffer member contacts a resilient material buffer secured to the base member when vibration displacements exceed a predetermined amplitude.

Preferably, the vibration isolating element comprises an elastomeric polymer formed by injection moulding to the base member. Conveniently, the resilient material buffer and the vibration isolating element are formed as an integral injection moulded unit.

It is an advantage that, for a given size of mounting, by arranging the buffers between adjacent lobes the thickness of resilient material disposed between the base member and support member can be sufficient to provide isolation of large amplitudes of vibration displacements as occur at low frequencies. For example, in embodiments of the invention, system natural frequencies as low as 6 Hz may be encountered.

In a preferred embodiment, the mounting location has a predetermined footprint and includes predetermined fastener positions within the footprint for securing the base member, the vibration mounting being sized to fit the predetermined footprint. The fastener positions may be holes for accepting mounting bolts.

The lobes are preferably arranged so as to allow access to, and not interfere with, the fastener positions.

In a preferred embodiment, the buffer member may contact the resilient material buffer when vibration displacements exceed a predetermined amplitude in the first direction.

The resilient material buffer may be provided with means for reducing friction when contacting the buffer member. The friction reducing means may be contact plates of nylon or other suitable low friction material. This prevents excessive wear or frictional heat generation when vibrations cause the contacting surfaces of the support member and the vibration isolating element to rub against one another.

In a preferred embodiment, in the first direction the vibration mounting further comprises a secondary buffer for further increasing resistance to displacement beyond a second predetermined amplitude of vibration displacement. It is an advantage that this dual buffering provides for greater control of vibration displacements and is particularly appropriate in applications such as the mounting of two or three-cylinder marine engines where increased resistance is required in a thrust direction when the engine is operating at a high capacity.

In a preferred embodiment, the vibration mounting includes further buffers for increasing resistance to displacement (stiffness rate) of the support member relative to the base member in the load-bearing direction and in a third direction beyond a threshold displacement in each direction. Preferably, the load-bearing, first and third directions are substantially mutually orthogonal directions.

It is an advantage that, in embodiments of the invention, different thresholds and stiffness rates may be provided in each direction, thereby allowing for differences in the control of vibrations in each direction. It is a further advantage that the control of displacements in each direction is provided in a single mounting.

Preferably, in the load-bearing direction the further buffer comprises a first buffer for increasing resistance to a positive displacement beyond a positive displacement threshold and a second buffer for increasing resistance to a negative displacement beyond a negative displacement threshold. The second buffer may be provided as a failsafe feature to prevent the support member and the base member becoming detached from one another in the event of a failure of the vibration isolating element.

Where the load bearing direction is the vertical direction, the positive and negative displacements being upward and downward displacements respectively, by providing different buffers for the upward and downward displacements allowance can be made for the dead weight of the load.

An embodiment of the invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a three-dimensional isometric view of a vibration mounting according to the present invention;

Figure 2 is a plan view in the direction X of part of the vibration mounting of Figure 1; and

Figure 3 is a sectional elevation in the plane A-A of the vibration mounting of Figures 1 and 2.

In marine engine applications, for example, 2 and 3 cylinder engines give rise to higher vibrations due to the difficulties of balancing the reciprocating masses in the engine. The vibrations that can also be low frequency are predominantly in the

vertical direction. For the engine mounting system to be effective it must have a natural frequency below the oscillation frequency at idle speed. This means that the mounting must have low stiffness allowing a large deflection under the engine mass.

Referring to Figure 1, a vibration mounting for an engine or other piece of machinery has a base member 10 which includes a plate portion 11. Holes 12 are provided in the plate portion 11 for bolting the vibration mounting to a floor or frame (not shown). The vibration mounting has a load-bearing support member 14 having a horizontal plate portion 15 between downwardly extending side walls 16a, 16b. The support member 14 is integrally formed with, welded to, or fixed by other means to an upwardly extending stud bolt 17 located centrally of the horizontal surface 15. In use, a hole provided in a footplate of an engine or other piece of machinery (not shown), is located over the stud bolt 17 onto the horizontal plate portion 15 of the load-bearing member 14 and secured in place with a nut. The footplate of the engine may not be in direct contact with the support member 14, but may be supported between two nuts screwed onto the stud bolt 17, thereby providing a height adjusting means.

The vibration mounting shown in Figures 1 to 3 is described herein for use as a horizontal mounting, but may be used in any orientation as required. In whichever orientation the vibration mounting is used, the predominant load-bearing direction should be that equivalent to the vertical direction of Figures 1 to 3.

The vibration mounting has a resilient rubber vibration-absorbing element 18 between the base member 10 and the support member 14. The base member 10, support member 14 and rubber element 18 are coupled together by a pin 20, as will be seen more clearly with reference to Figures 2 and 3.

Figure 2 shows a plan view of the vibration mounting with the support member 14 of Figure 1 removed. The rubber element 18 is an injection-moulded unit, which is shaped to provide vibration isolation and control of the extents of vibration displacements between the support member 14 and the base member 10. The rubber element 18 has a central portion 22 and four lobes 24 which extend outwardly and upwardly from the central portion in an X-shape as seen in Figure 2.

The central portion 22 of the rubber element 18 has an upwardly facing surface 26 and vertical surfaces 28a, 28b which face outwardly in opposing lateral directions. The central portion 22 of the rubber element 18 also carries a pair of nylon plates 30a, 30b on the vertical surfaces 32a, 32b facing outwardly in opposing longitudinal directions between respective pairs of the lobes 24. The nylon plates 30a, 30b are either fixed by adhesive to the vertical surfaces 32a, 32b, or bonded to the vertical surfaces 32a, 32b when formed by injection moulding.

The upwardly facing surface 26 is shown as a flat horizontal surface in Figures 2 and 3, but may be profiled to provide a softer buffer.

Referring to Figure 3, the base member 10 includes an upwardly extending frusto-conical portion 34 with a flat top surface 36. One or more holes 38 are provided through the base member 10 in the top surface 36. The rubber vibration-absorbing element 18 is formed by injecting the rubber from above the frusto-conical portion 34 and through the holes 38 so as to be moulded to the base member 10. The rubber element 18 includes a lower portion 40 moulded to the underside of the frusto-conical portion 34. A U-shaped channel 42 is formed through the lower portion 40, extending across it in the lateral direction.

The support member 14 is coupled to the base member 10 and rubber element 18 by inserting a pin 20 through holes in the side walls 16a, 16b (as shown in Figure 1) and through correspondingly aligned holes (not shown) in the fusto-conical portion of the base member 10. A central portion of the pin 20 rests within the curved surface of the U-shaped channel 42 in the lower portion of the rubber element 18. The upper surfaces of the lobes 24 bear against an underside 44 of the support member 14, and are compressed slightly when the vibration mounting is assembled.

Embodiments include the support member 14 having downwardly extending end portions that bear against the outer end surfaces of the lobes. This helps to provide further support for the load in the longitudinal direction. The end portions provide accurate control of stiffness, ensure that the rubber lobes are compressed, and

substantially reduce the friction caused by relative movement between the rubber and the support member.

The support member 14 is further provided with a pair of downwardly extending arms 43a, 43b, which are spaced apart by an amount which is a little greater than the longitudinal separation of the outwardly facing surfaces of the nylon plates 30a, 30b, so as to leave a gap between each arm 43a, 43b and a corresponding nylon plate 30a, 30b. Similarly, the central portion 22 of the rubber element 18 is sized to have a lateral length slightly less than the lateral separation of the side walls 16a, 16b of the support member 14 so as to leave a gap between the side walls and the vertical surfaces 28a, 28b.

When an engine is mounted on the vibration mounting, the weight of the engine causes the lobes 24 to be compressed and to be deflected downwards so that the mounting plate 24 is pushed closer to the base member 10. The gap between the underside 44 of the support member 14 and the horizontal surface 26 of the central portion 22 of the rubber element 18 is reduced, while the gap between the pin 20 and the curved surface of the U-shaped channel 42 is increased. This downward displacement of the lobes does not affect the gaps between the downwardly extending arms 43a, 43b and the respective nylon plates 30a, 30b, nor the gaps between the side walls 16a, 16b and the corresponding vertical surfaces 28a, 28b.

In use the rubber lobes 24 reduce the transfer of energy from the vibrating load to the base member 10 in 3 ways: a) low stiffness allows the load to move (vibrate) with a low transfer of energy, b) by reducing the natural frequency of the system to a level below all normal running frequencies a resonance condition is avoided, and c) by energy absorption due to the damping effect of the rubber (hysteresis).

Vibration displacements of the support member 14 cause the lobes 24 to deform in compression or in shear. The free surfaces of the lobes are able to expand outwardly when so deformed and so provide a relatively low rate of energy transfer (stiffness). This means that under relatively mild vibration conditions, when vibration amplitudes are small enough for there to be no contact of the buffer surfaces, the

stiffness of the rubber element 18 is relatively low. This is desirable because at low vibration frequencies, the displacement levels required to isolate the vibrations are high.

The arrangement of the lobes 24 has a further advantage in that low frequency vibration isolation can be achieved in a mounting having the same mounting bolt positions as existing, industry-standard mountings. Standard boat mountings have sub-frames that are 60mm wide and have a standard bolt hole pattern (100mm between bolt centres). The size of the mounting is very restricted by the space envelope exists, especially in small engine boats. In the embodiment described, the lobes extend outwardly away from the mounting bolt holes 12 in the plate portion 11 of the base member 10 and so are not fouled by the bolts. The mounting can therefore be secured using existing standard bolt positions.

However, when vibration levels become severe, then to prevent dangerously large vibration displacements, a higher rate of energy transfer is required. This is achieved by buffered limit control in vertical, lateral and longitudinal directions. Buffering protects the mounting as well as the engine and engine attachments (fuel lines, exhaust, propshaft, etc.) from excessive deflections.

In the lateral direction, vibration displacements greater than the size of the gap between the side walls 16a, 16b and the respective vertical surfaces 28a, 28b of the vibration-absorbing element 18, cause the gap to close. The rubber of the central portion 22 of the rubber element 18 acts as a buffer by absorbing more of the lateral vibration energy. In other words, there is an increase in the resistance to vibration displacements greater than the size of the gap. The increase in resistance depends on the material properties of the rubber as well as the thickness of rubber between the vertical surfaces 28a, 28b and the metal of the frusto-conical portion 34 of the base member 10.

A similar situation arises for the buffering of vertical displacements. However, in this case there is a difference between downward and upward displacements. For downward, or positive, displacements, the gap between the

underside 44 of the support member 14 and the upwardly facing surface 26 of the rubber element 18 is closed until, for large displacements buffering occurs when contact is made. For upward, or negative, displacements, the gap between the pin 20 and the curved surface of the U-shaped channel 42 is closed until, for large displacements, buffering occurs when contact is made. The amount of buffering (the resistance to further displacement) in each case depends on the material properties of the rubber, the thickness of rubber between the contacting surface and the under or over-lying surface of the base member 10, and the area of contact. Thus a different degree of buffering can be provided for upward and downward displacements to allow for the effects of the dead weight of the engine.

In the longitudinal direction, a two-stage control of displacement is achieved. A first stage occurs when the gap between one of the downwardly extending arms 43a, 43b and the corresponding adjacent nylon plate 30a, 30b is closed. The nylon and rubber of the rubber element 18 between the nylon plate 30a, 30b and the frusto-conical portion 34 of the base member 10 acts as a first stage buffer. Greater displacement in the longitudinal direction closes the gap between the pin 20 and the side walls of the channel 42 in the lower portion 40 of the rubber element 18. This lower portion 40 acts as the second stage buffer. Again the degree of buffering depends on the relative dimensions of the contacting surfaces and the thickness and material properties of the rubber.

Two-stage buffering in the longitudinal direction means that this direction can be aligned with the primary thrust direction of the engine. Vibration displacements in the thrust direction require a greater degree of control, especially at high engine loads. Hitherto vibration isolation in this direction has required separate components such as thrust bearings to be used in addition to vibration mountings for the feet of the engine.

The nylon plates 30a, 30b are provided to reduce friction between the downwardly extending arms 43a, 43b and the buffer surface. Because vibrations can occur in all directions, when the downwardly extending arms contact the nylon plates, vibrations in directions parallel to the contacting surfaces cause the surfaces to rub

against each other, and reduced friction between them reduces heat generation and wear.

Thus, a single vibration mounting may provide for vibration isolation and control in all three orthogonal directions even when the degree of control required is different in each direction.

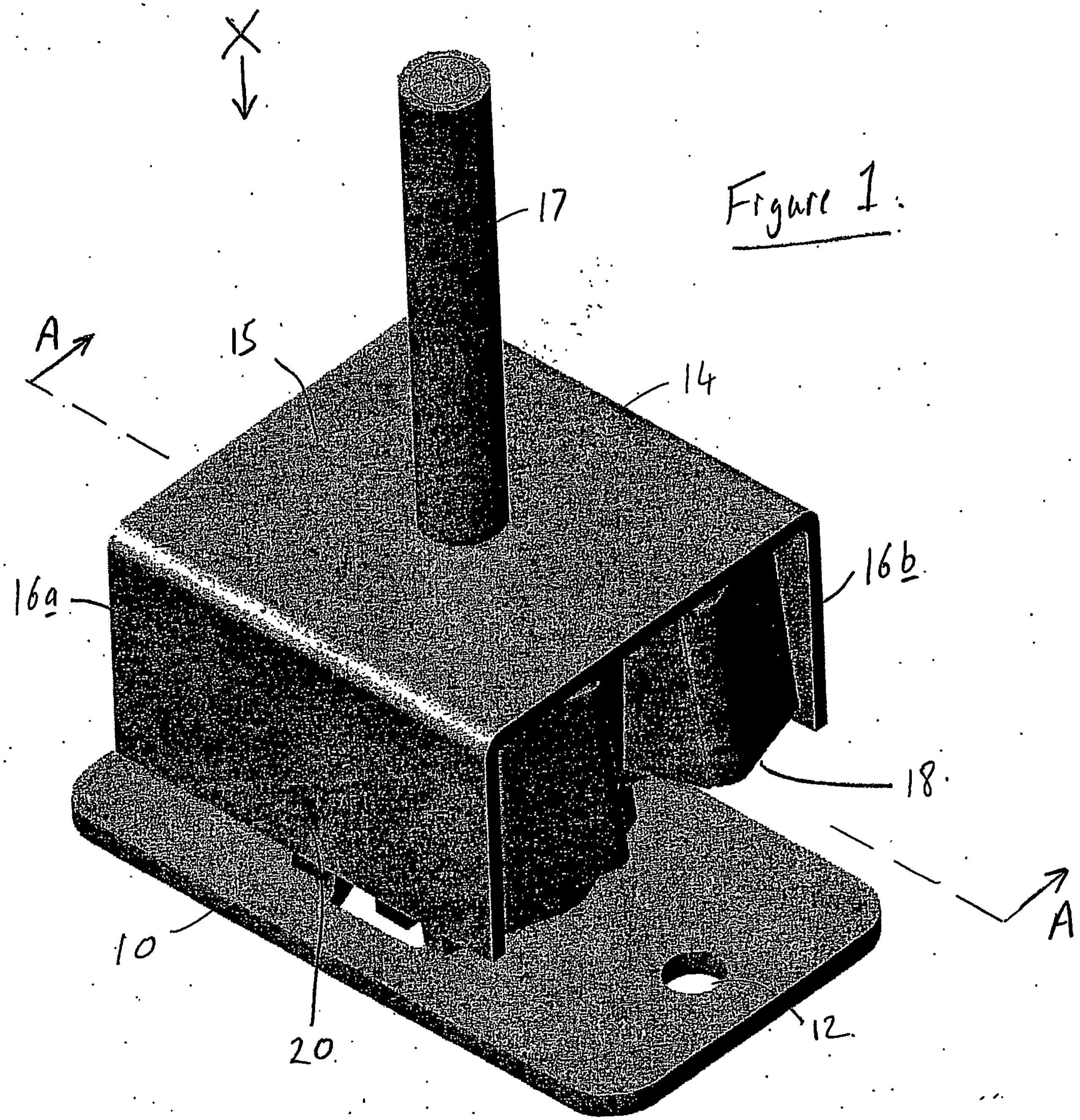

Figure 1.

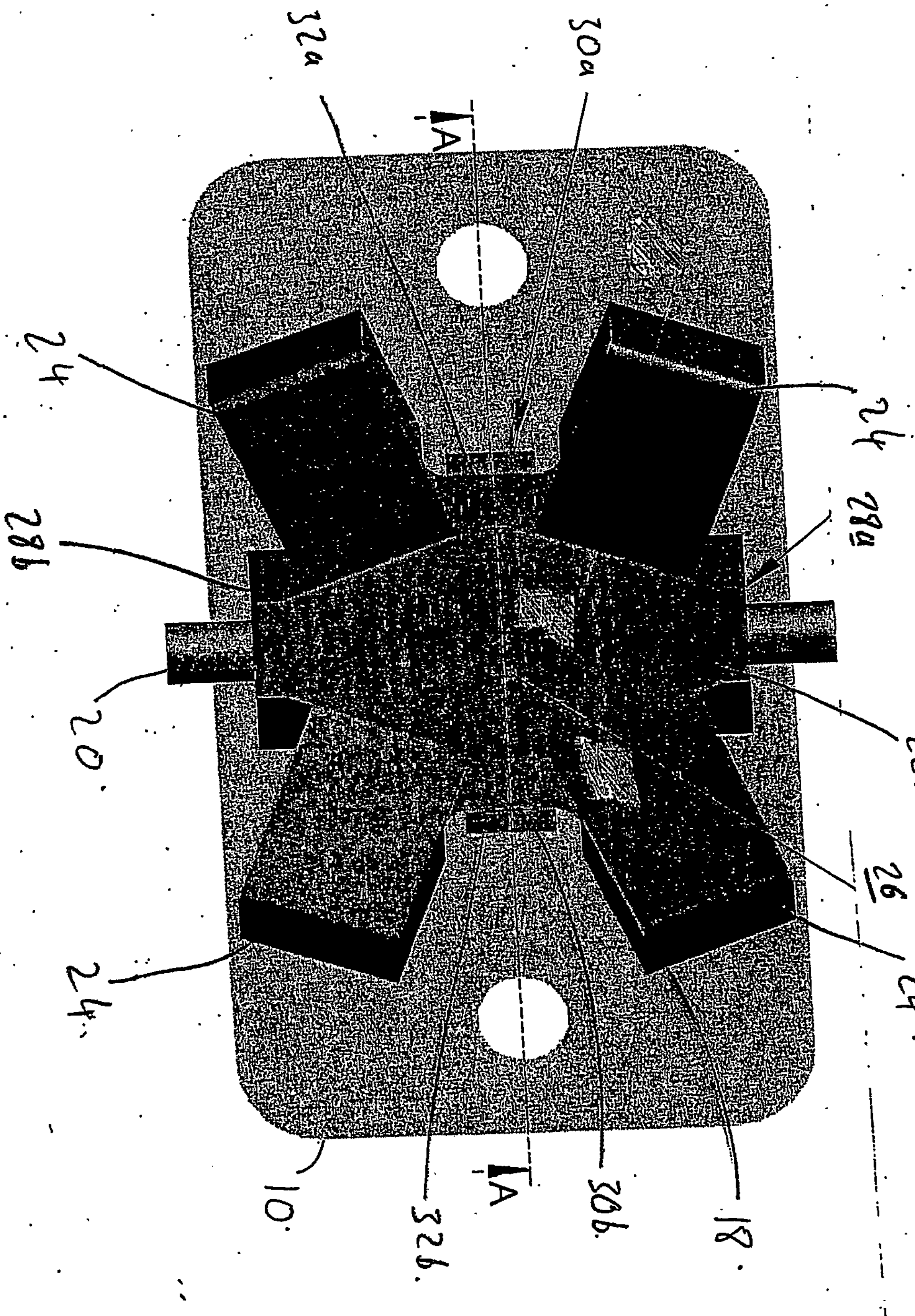

Figure 2

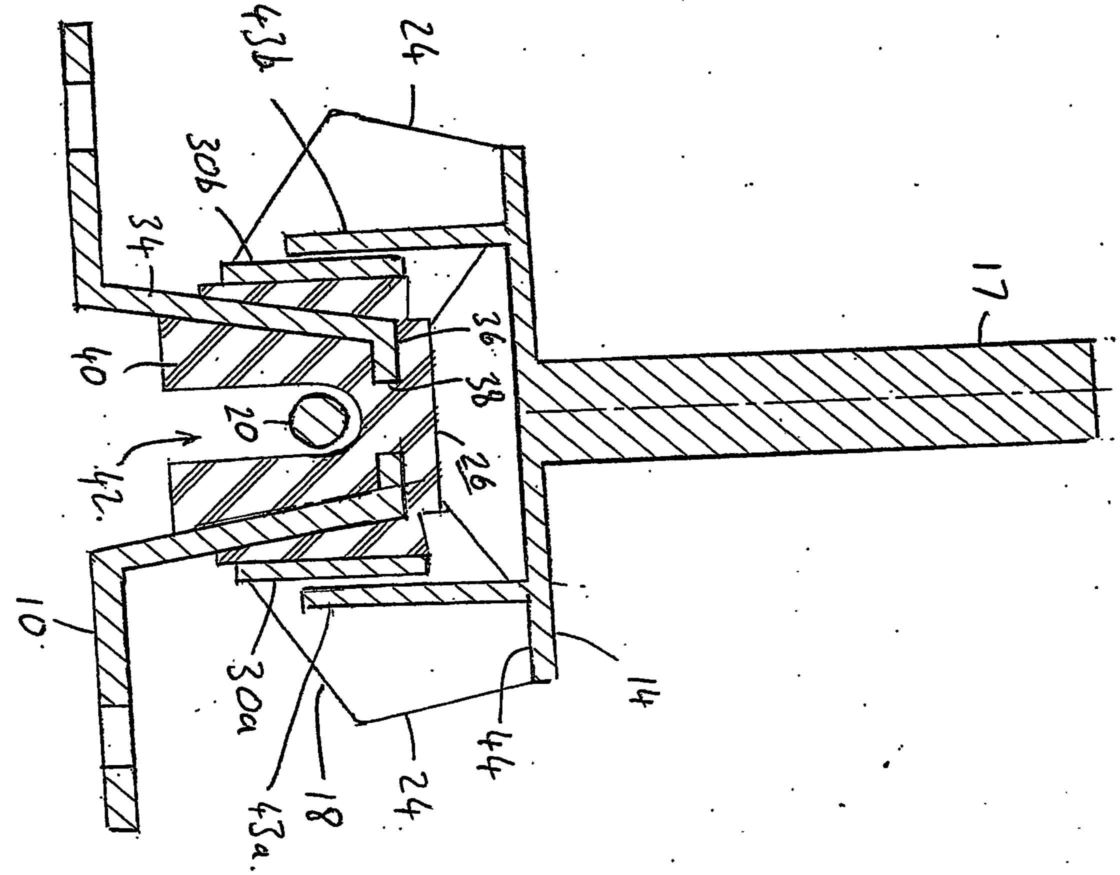

Figure 3